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(71) Applicant: BRITISH TELECOMMUNICATIONS PUBLIC LIMITED COMPANY [GB/GB]; 81 Newgate Street, London EC1A 7AJ (GB).

(72) Inventors: FROST, Peter, Lewis, John; 14 Copswood Close, Kesgrave, Ipswich, Suffolk IP5 7QF (GB). KERRY, John; 4 The Grove, Martlesham Heath, Ipswich, Suffolk IP5 7UZ (GB). JESSOP, Paul; 5 Waypond Court, Wellesley Road, Clacton-on-Sea, Essex CO15 3PW (GB). WETTENGEL, Paul, Frederick; 3 Peel Yard, Martlesham Heath, Ipswich, Suffolk IP5 7UL (GB). BENTON, Simon, Charles, Tristan; Minima Design & Development, Minima the Black Granary, Station Yard, Framlingham, Woodbridge, Suffolk IP13 9EE (GB).

(74) Agent: PRATT, David, Martin; BT Group Legal Services, Intellectual Property Dept., 13th floor, 151 Gower Street, London WC1E 6BA (GB).

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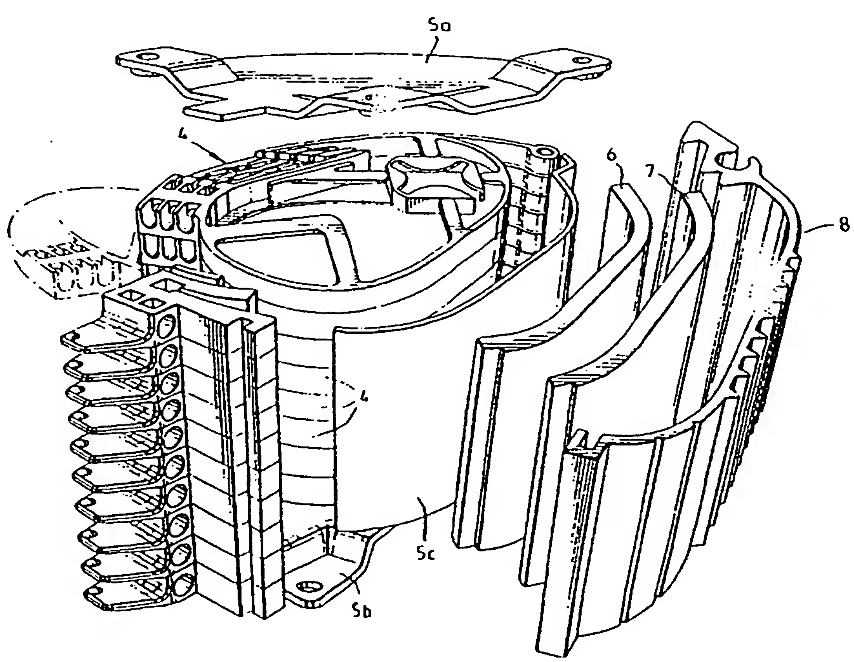


(57) Abstract

A break-out tray (T) is disclosed for separating the fibre end portions formed by cutting one or more fibres of a multi-fibre cable (C) from the remaining fibres in the cable. The break-out tray (T) includes means (B) for guiding the fibre end portions to a fibre exit portion of the tray, and means (3) for storing a length of uncut cable.

BREAK-OUT TRAY

This invention relates to an optical fibre management system, and in particular to a break-out tray of an optical fibre splitter array sub-assembly for incorporation in the node of an optical fibre telecommunications network.

In the United Kingdom, the telecommunications network includes a trunk network which is substantially completely constituted by optical fibre, and a local access network which is substantially completely constituted by copper pairs. Flexibility in the copper access network is provided at two points en route to the customer; firstly, at street-side cabinets serving up to 600 lines; and secondly, at distribution points serving around 10-15 lines. In total, the network has about 250,000km of underground ducts, 83,000 cabinets, 3.1 million distribution points and 3.7 million manholes and joint boxes. Eventually, it is expected that the entire network, including the access network, will be constituted by fibre.

The ultimate goal is a fixed, resilient, transparent telecommunications infrastructure for the optical access network, with capacity for all foreseeable service requirements. One way of achieving this would be to create a fully-managed fibre network in the form of a thin, widespread overlay for the whole access topography as this would exploit the existing valuable access network infrastructure. Such a network could be equipped as needs arise, and thereby could result in capital expenditure savings, since the major part of the investment will be the provision of terminal equipment on a 'just in time' basis. It should also enable the rapid provision of extra lines to new or existing customers, and flexible provision or reconfiguration of telephony services.

In order to be completely future proof, the network should be single mode optical fibre, with no bandwidth limiting active electronics within the infrastructure. Consequently, only passive optical networks (PONs) which can

will result from:

(i) reducing the number of fibres at the exchange and in the network;

(ii) reducing the amount of terminal equipment at the exchange;

(iii) sharing the cost of equipment amongst a number of customers;

(iv) providing a thin, widespread, low cost, fibre infrastructure; and

(v) providing a high degree of flexibility, and allowing 'just in-time' equipment and service provision.

Additionally, PON architecture can be tailored to suit the existing infrastructure resources (duct and other civil works).

Total network transparency will retain the option for future services to be provided on different wavelengths to the telecommunications, which for TPON is in the 1300nm window. By transmitting at other wavelengths, other services, such as broadband access for cable television and high definition television, or business services, such as high bit rate data, video telephony or video conferencing, can be provided. The huge bandwidth potential of fibre promises virtually unlimited capacity for the transparent network. Eventually, it will be possible to transmit hundreds of wavelengths simultaneously, as the development of technology in optical components, such as narrow band lasers, wavelength division multiplexers (WDMs), optical filters, fibre amplifiers and tunable devices, moves forward.

For this potential to remain available, and for the access network to be used to provide many and varied services, then it must be designed and engineered to provide very high levels of security and resilience. Even for simple POTS, advance warning and live maintenance are essential to limit disruption.

Resilience implies separacy of routing, and exploiting the existing infrastructure of underground ducts and other civil works is a prime requirement of the design philosophy.

in the cable, the breakout means including guide means for guiding the fibre end portions to a fibre exit region, and store means for storing a length of uncut cable.

In a preferred embodiment, the guide means is constituted by a plurality of curved guide fingers, adjacent pairs of which define channels for guiding fibre end portions to the fibre exit portion. Preferably, the guide means and the store means are provided on a tray-like member, and the fibre exit region is constituted by a fibre exit portion provided on the tray. The tray may further comprise means for storing lengths of fibre end portions.

The invention will now be described in greater detail, by way of example, with reference to the accompanying drawings, in which:-

Figure 1 is a perspective view, for one side, of an optical fibre telecommunications network node incorporating three splitter array sub-assemblies each of which is constructed in accordance with the invention;

Figure 2 is a perspective view, form the opposite side, of the node of Figure 1;

Figure 3 is a perspective view showing the node of Figures 1 and 2 mounted in a footway box in a storage position;

Figure 4 is a perspective view similar to that of Figure 3, but showing the node 2 mounted in the footway box in its working position;

Figure 5 is an exploded perspective view of one of the splitter array sub-assemblies of the node of Figures 1 and 2;

Figure 6 is a perspective similar to that of Figure 5, but showing parts of the sub-assembly, then parts being in their operative positions;

Figure 7 is a perspective view of one of the splice trays of the splitter array sub-assembly of Figures 5 and 6;

Figure 8 is a plan view showing the fibre entry/exit portion of the splice tray of Figure 7.

Figure 9 is a perspective view of one of the bend-limiting tube manifolds of the splitter array sub-assembly of

footway box F, a dome-shaped cover D being fixed to the node base 1 prior to mounting.

One of the splitter array sub-assemblies, S_1, is shown in detail in Figures 5 and 6. The other two sub-assemblies S_2 and S_3 are the same as the sub-assembly S_1. The sub-assembly S_1 includes a stack of ten splice trays 4, each of which is 8mm thick. The trays 4 are supported (in a manner described below) by a stainless steel chassis 5 constituted by a top plate 5a, a base plate 5b and a back plate 5c. Each of the splice trays 4 is a single circuit splice tray, that is to say, in use, it has two incoming optical fibres (one each for transmitting and receiving), and two outgoing optical fibres (one each for transmitting and receiving). The three plates 5a, 5b and 5c are welded together, and the top plate 5a of the sub-assembly S_1 can be fixed to the base plate 5b of the adjacent sub-assembly S_2 (not shown in Figures 5 and 6) by means of mounting bolts (not shown). Similar mounting bolts can be used to fix the plate 5a of the sub-assembly S_1 and the plate 5b of the sub-assembly S_3 to support means (not shown) in the node N.

The chassis 5 also supports an input splitter array mat 6, an output splitter array mat 7, and a splitter array back cover 8. In this connection, the input mat 6 carries (as is described below with reference to Figure 10) fibres which carry telecommunications signals from the exchange to customers. These fibres are termed transmit fibres. Similarly, the output mat 7 carries fibres which carry telecommunications signals from customers to the exchange. These fibres are termed receive fibres. The mats 6 and 7 are made of a flexible polymer, for example an elastomeric polymer such as injection mouldable zantoprene, or polyurethane. The back cover 8 is made of flexible polypropylene (which is also injection mouldable). This inherent flexibility ensures that, in use, the mats 6 and 7 are held firmly against the chassis back plate 5c by the back cover 8.

As shown in Figure 7, each splice tray 4 has a main

Each splice tray 4 is also provided with a number of fibre retention tabs 23 for holding fibre in the various channels 11, 13, 14, 16, 18a, 18b, 20a, 20b and 22. One of these tabs (indicated by the reference numeral 23a) is generally V-shaped, and extends from the curved end of the peripheral wall 9b remote from the mandrel 12 about halfway across, and above, that portion of the base 9a between that wall portion and the mandrel.

Each tray 4 is pivotally mounted on the splitter array back cover 8 by means of a leash 24 and a retaining ring 25 which are moulded integrally with the rest of the tray. The leash 24 of each tray 4 has two arms 24a and 24b joined together by a hinge 24c. Its retaining ring 25 is a friction fit within a groove 26 formed in the back cover 8 (see Figure 11). In use, a rod (not shown) passes through all the retaining rings 25 and through apertures (not shown) in the top and base plates 5a and 5b. In this way all the splice trays 4 are retained by their back plates 5c, but each can be pivoted out away from the other trays in the stack to provide access to its clip-on apertures 19a, 19b, 21a and 21b. In this position, the arms 24a and 24b take up a generally straightline configuration (as opposed to the V-shaped configuration they have when the tray is in the stack). As the retaining ring 25 of a pivoted-out tray 4 is held in position by the retaining rod, the pivotal movement of the tray is limited by the leash 24 as its two arms 24a and 24b straighten out. In the fully pivoted-out position (the first operating position), the fibre entry portion 10 of a tray 4 is exposed.

Each of the splitter array sub-assemblies S_1, S_2 and S_3 is associated with two fibres (four fibre end portions) of the eight fibres in the cut tube of the cable. The remaining two fibres (four fibre end portions) from the cut tube are stored in the break-out tray T as is described below with reference to Figure 13. As the cable C is in the form of a ring, telecommunications signals can travel to/from the exchange in either direction round the ring. For

channel 11. They are then led to the port 17c of the entry portion 10 via the clip-on windows 21a and 21b and the channels 20a and 20b. These fibres are then led to the mats 6 and 7 within a bend limiting tube 27c (see Figure 6). One of these main input fibres terminates on the input mat 6, where (as is described below with reference to Figure 10) it is joined by splitter means to eight output fibres. Similarly, the other of these main input fibres terminates on the output mat 7, where it is joined by splitter means to eight output fibres.

The two standby fibre end portions associated with this splitter array sub-assembly S_1 pass from the break out tray T to the second lowest splice tray 4 of that assembly. Here, these two fibre end portions are spliced to two fibres which are led back to the mats 6 and 7 and so are termed standby input fibres, and each of the standby input fibres is joined by splitter means to the same eight output fibres as the corresponding main input fibre. The fibre arrangement on this second lowest splice tray 4 is the same as that for the lowest splice tray. Similarly, fibres enter and leave this splice tray 4 in bend limiting tubes 27a and 27c.

The remaining eight splice trays 4 in the sub-assembly S_1 of Figures 5 and 6 are customer splice trays. As the fibre arrangement in each of these customer splice trays 4 is the same, this will be described in detail for only one of these trays. Thus, one of the output fibres from each of the mats 6 and 7 (that is to say a transmit fibre and a receive fibre) is led to the port 17c of a given customer splice tray 4 inside a bend limiting tube 27c. These two fibres are led into the main body portion 9 of the tray 4 via the channels 20a and 20b, the clip-on windows 21a and 21b, and the channel 11. In use, these fibres are spliced to two fibres of a four-fibre blown fibre unit associated with a given customer. Such a unit has four fibres in a single tube, the tube being fed between the customer and the node N by the well known fibre blowing technique (see EP 108590). The customer's blown fibre unit is led to the port 17a of the splice tray 4

can provide up to 32 lines using customer premises equipment (CPE) electronics such as an optical network unit (ONU) matched to an optical line terminal (OLT) at the exchange. Each pair of fibres can also provide a Megastream service.) In this case, the two spare fibres are removed from their storage position within the mandrel 12, and are led to the fibre entry portion 10 of the tray 4 via the channels 13 and 11. They then leave the tray 4, via the apertureless channel 22 and the port 17b, and enter a bend limiting tube 27b (see Figure 6). This tube 27b is routed via the back cover plate 8 to another splice tray 4 - usually a splice tray of another of the sub-assemblies S_2 or S_3 of the node N. The tube 27b terminates at the port 17a of this tray 4, and the two fibres are led into the main body portion 9 via the channels 18a and 18b, the apertures 19a and 19b, and the channel 11. Here they are spliced to two "exchange" fibres, and all spare lengths of fibre are stored in the same manner as that described above for the other splice trays. In this connection, the "exchange" fibres could be either a second pair of fibres from the break-out tray T (direct exchange fibres), or a pair of output fibres from the mats 6 and 7 (indirect exchange fibres).

The bend limiting tubes 27a, 27b and 27c of each of the splice trays 4 are provided with respective support manifolds M (see Figures 6 and 9). Each manifold M is a sliding friction fit on a flanged portion (not shown) of the chassis back plate 5c, and is provided with an open aperture 28a for supporting the associated bend limiting tube 27a, and with a pair of closed apertures 28b and 28c for supporting respectively the associated bend limiting tube 27b (if there is one) and the associated bend limiting tube 27c. The manifolds M are made of injection moulded filled nylon.

Figure 10 shows the input mat 6 of the sub-assembly S_1. The output mat 7 of this sub-assembly, being of identical construction to the input mat 6, will not be described in detail. The mat 6 includes an input slot 29 for receiving the main input fibre, and an input slot 30 for receiving the

back cover 8 is formed with an in-turned L - shaped flange 8b which can be snapped over grooves 28d formed in the manifolds M to hold the back cover to the chassis 5 with the mats 6 and 7 firmly sandwiched therebetween.

The outer surface of the back cover 8 is also provided with a plurality of longitudinally-extending ribs 8c, the base of each rib being formed with a plurality of apertures 8d. These apertures 8d extend right through the back cover 8 to its inside surface, and constitute a matrix of tie points for the attachment of cable ties which are used to tie the bend limiting tubes 27a, 27b and 27c to the sub-assembly S.

Figure 12 shows the break-out tray T in greater detail. As mentioned above, two loops of the cable are stored in the track 3, before the cable exits the break-out tray T via the entry portion 2, and one of the tubes of the cable is cut in the middle of its stored length. One of the cut fibres forms the main fibre for the splitter array sub-assembly shown in Figures 5 and 6, and another the standby fibre for that sub-assembly. The remaining fibres can be main and standby fibres for other splitter array sub-assemblies S_2 and S_3 of the node N, or can be stored around a mandrel 39 at that end of the tray T remote from the cable entry portion 2. The mandrel 39 has a rounded rectangular cross-section, and is sized so that fibre coiled therearound does not exceed minimum bend radius requirements.

The break-out region B of the tray T is formed with a plurality of curved upstanding fingers 40, adjacent pairs of which define sixteen fibre feed channels 41. The two fibre end portions that constitute the main fibres associated with the lowest splice tray 4 of the sub-assembly S_1, are fed through the first channel 41 (that is to say through the channel nearest the entry portion 2). Similarly, the two fibre end portions that constitute the standby fibres associated with the second lowest splice tray 4 are fed through the second channel 41. (As there are sixteen channels 41, the break-out tray T can handle sixteen pairs of

sub-assembly if required.

An important advantage of the sub-assemblies described above, is that the splitters and the associated fibres can all be factory fitted. Thus, the fused and planar couplers and their associated fibres can be made and positioned in the mats 6 and 7, and the associated fibres can be led to their splice trays 4 within bend limiting tubes - all at the factory. When the sub-assembly is to commissioned, the fitter needs only to cut one or more tubes of the cable C, feed main and standby fibre end portions to the lowest two splice trays 4 of the sub-assembly, store spare cut fibre end portions in the break-out tray T, splice the main and standby fibre end portions to the main and standby input fibres already present in the two splice trays, and to splice "customer" fibres to the fibres already present in the other splice trays 4. In this way, the amount of skilled work which has to be carried out on site is reduced to a minimum. In particular, the fitter does not need to carry out any intricate splicing for splitting purposes. Moreover, the bend limiting tubes ensure that the fibres guided therein are never bent beyond the minimum bend requirements for live fibre even when the splice trays are pivoted out of the stack to either of their operating positions. This guarantees the transmission performance of live fibres carried by the bend limiting tubes.

The sub-assembly described above could also be adapted for use in a spur joint. In such a case, no splitting is required, so the sub-assembly would not include the mats 6 and 7. In a first type of spur joint, all twelve tubes of the fibre cable C would be cut, thereby forming twelve main fibre tube ends and twelve standby fibre tube ends. The fibres of six of the main fibre tube ends would then be spliced to the fibres of six of the standby fibre tube ends in special (single element) splice trays 45 (as is described below with reference to Figure 14). The fibres of the remaining six main fibre tube ends are then spliced to "customer" fibres in 24 splice trays 4. Similarly, the

expose the fibres. The fibres are then fed into the main body portions 46 of the trays, where they are spliced. The eight splices in each tray 45 are then positioned, four in each of a pair of splice holders, and the splice holders are then mounted in the regions 53. The fibres leading to the splices are then stored in the main body portions 46 of the trays 45. A length of each of the fibres is stored in the main body portion 46 of the associated tray 45 by passing these fibres one or more times round an upstanding mandrel 59 and under the tabs 54. The fibres' natural resilience will ensure that the loops of fibre expand outwardly to a configuration of varying diameter turns. The provision of stored fibre permits re-splicing to be carried out during the lifetime of the assembly.

In a modified version of the spur joint described above, only six of the tubes are cut, the fibres in these tubes being spliced to "customer" fibres in 48 splice trays 4 as described above. The remaining six uncut tubes are looped around a break-out tray. Alternatively, instead of using 48 splice trays 4, six splice trays 45 could be used. This alternative would, however, only be used in cases where there is no need to access spur joints for future use.

Obviously, for either type of spur joint, the number of fibres forming the spur can be varied. For example, the spur could be formed from the fibres of one cut tube. In this case the spur would contain 16 fibres (eight main fibres and eight standby fibres from a single cut tube) and 88 fibres (from the remaining eleven tubes - either cut and spliced or uncut and coiled) would continue through on the ring.

Fig.1

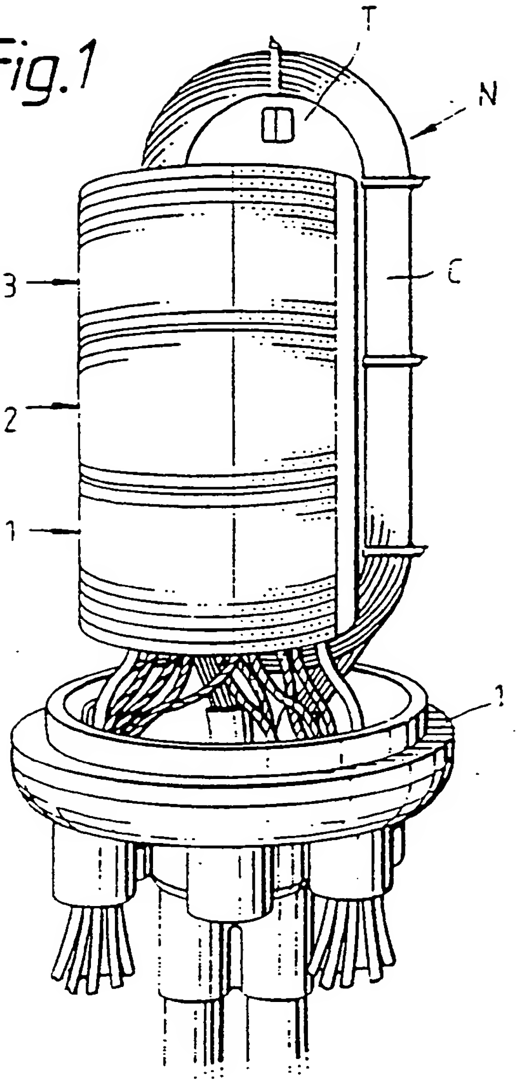
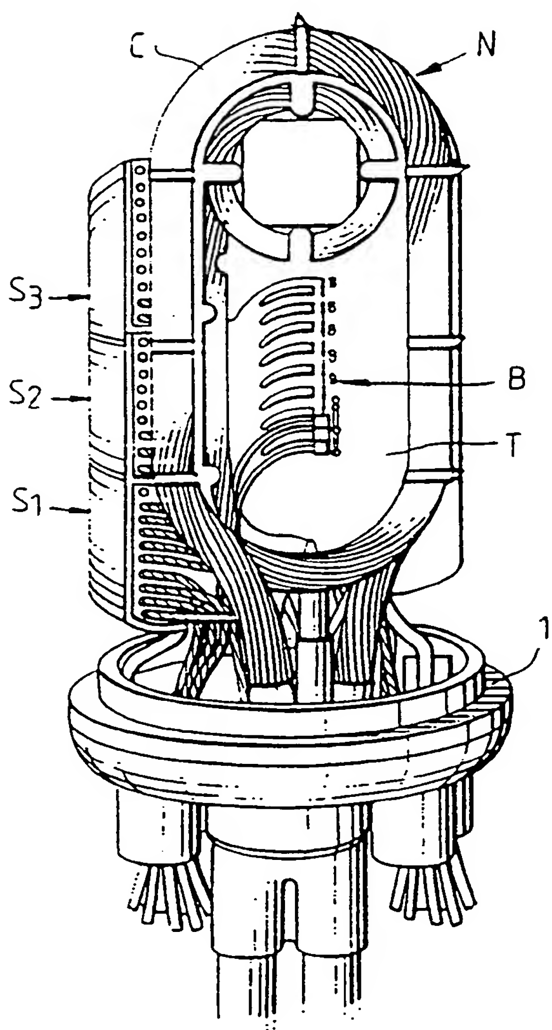


Fig.2



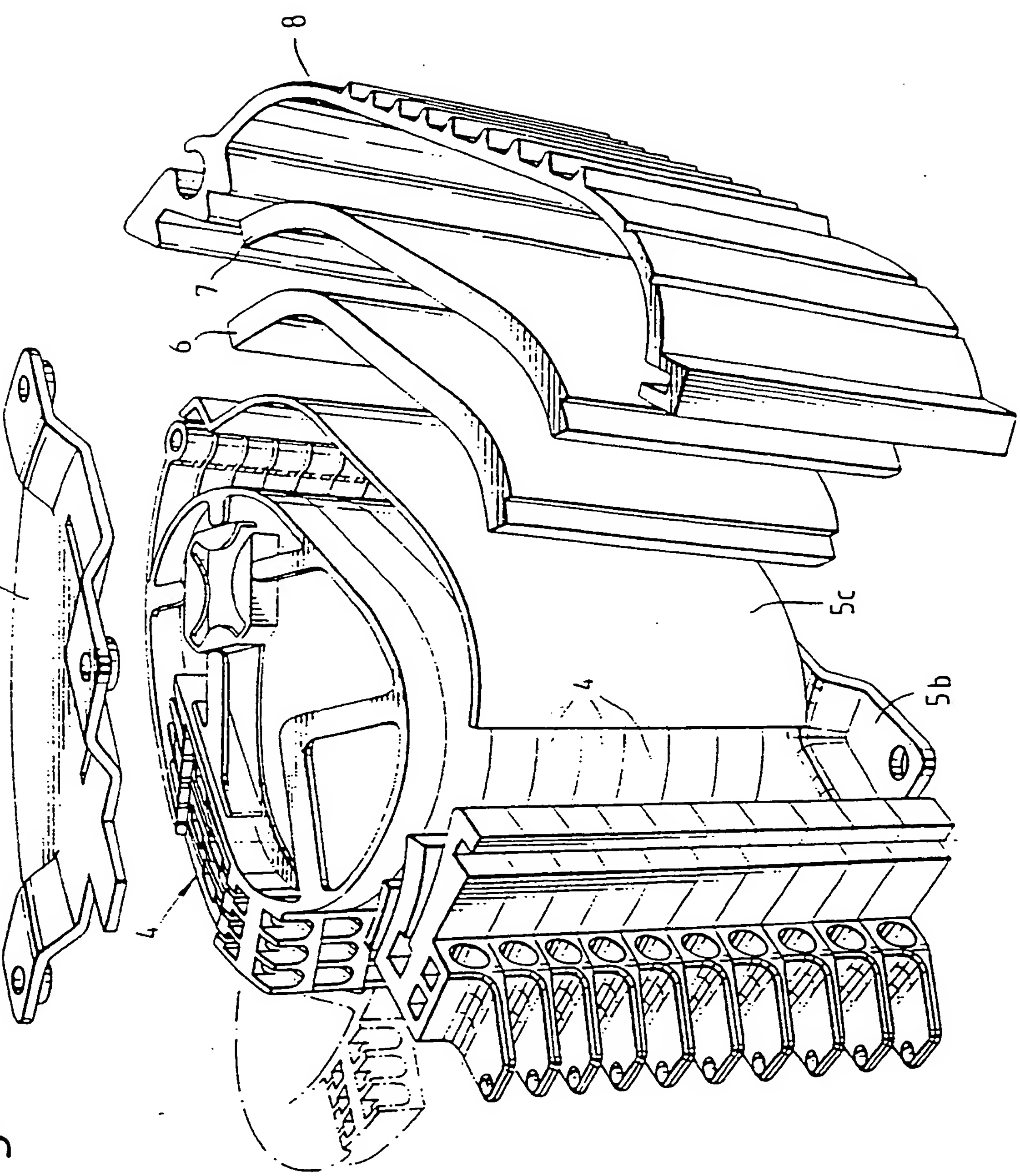
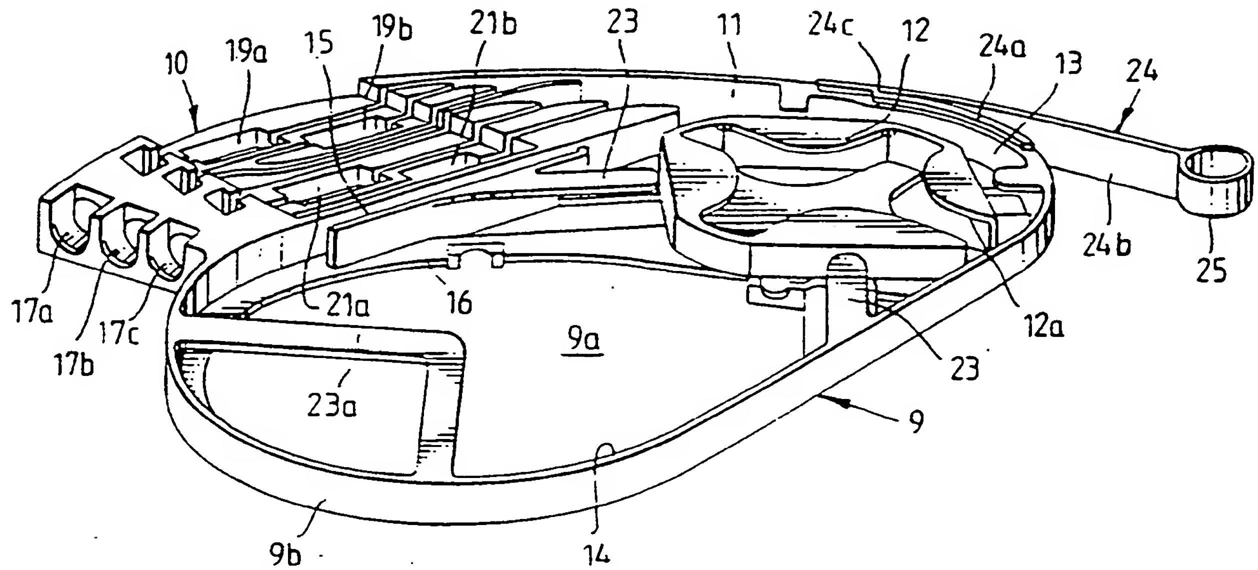


Fig.5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19a
15
19b
21b
23
11
24c
12
24a
13
24
17a
17b
17c
21a
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9a
23a
23
12a
24b
25
9
9b
14

Fig 7

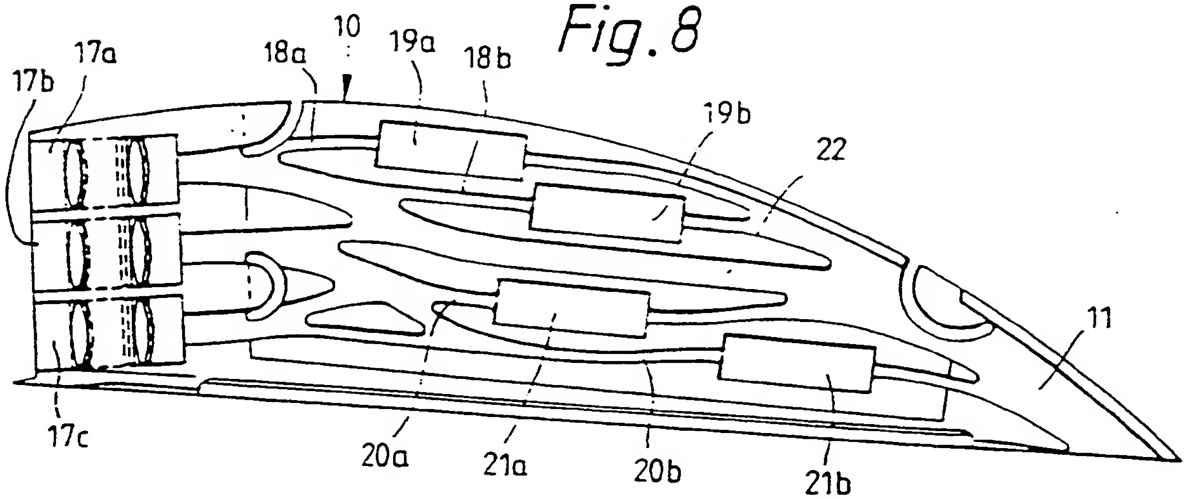
17b
17a
18a
10
19a
18b
19b
22
11
17c
20a
21a
20b
21b

Fig.8

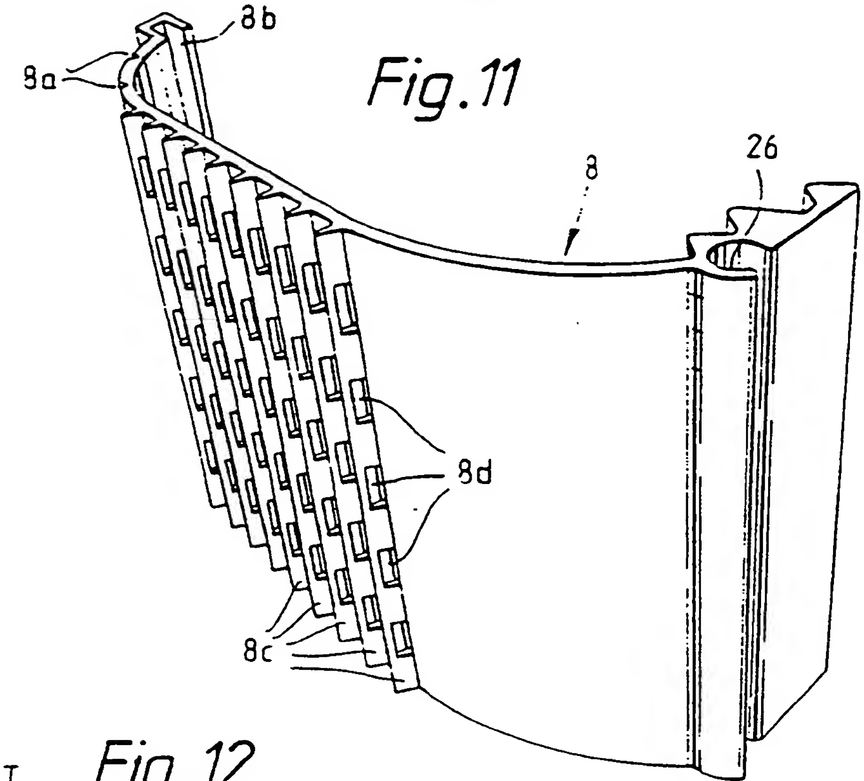

Fig.11

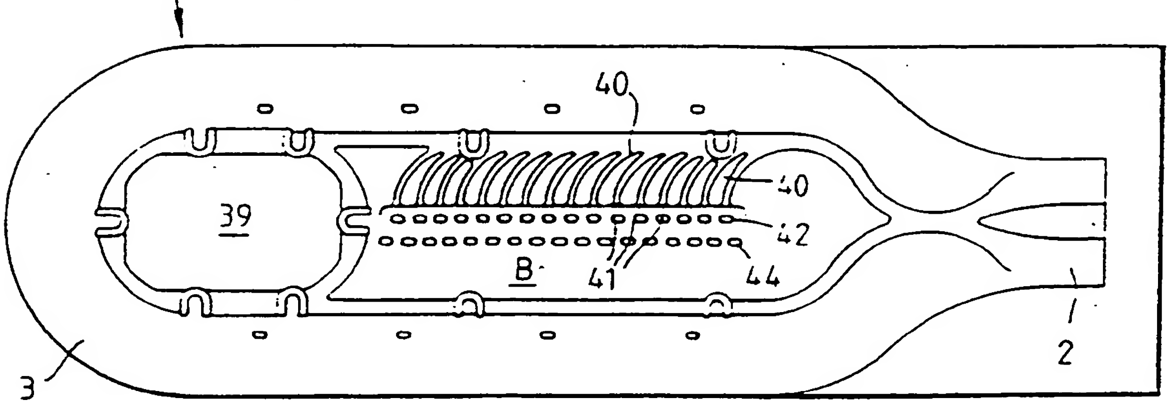

Fig.12

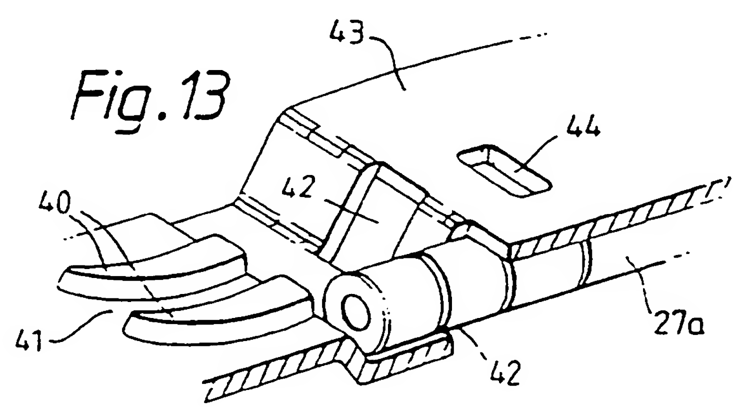

Fig.13

INTERNATIONAL SEARCH REPORT

International Application No
PCT/GB 94/01959

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B6/00 G02B6/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 490 644 (ATT) 17 June 1992 see claims; figures ---	1
A	EP,A,0 159 857 (RAYCHEM) 30 October 1985 see claims; figures ---	1-4
A	WO,A,91 08574 (RAYNET) 13 June 1991 see claims; figures ---	1-4
A	WO,A,90 05930 (RAYCHEM) 31 May 1990 see claims; figures ---	1-4
A	WO,A,90 12334 (B.T.) 18 October 1990 see claims; figures ---	1,2
A	DE,A,40 30 310 (SIEMENS) 26 March 1992 see claims; figures --- -/--	1-4

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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1

Date of the actual completion of the international search	Date of mailing of the international search report
30 November 1994	14. 12. 94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Pfahler, R

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INTERNATIONAL SEARCH REPORT

Information on patent family members

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PCT/GB 94/01959

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